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(54) Abstract Title

Lubricant compositions for transmissions

(57) Transmission lubricant compositions comprise a mineral oil as a base oil of which %CP and %CA defined in ASTM D 3238 are 70 or more and 3 or less, respectively, a viscosity index improver, and a friction modifier. The transmission lubricant compositions have excellent low temperature fluidity, shear stability, and durability of anti-shudder properties and thus can be used for extended periods of time.

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Lubricant Compositions for Transmissions

This invention relates to lubricant compositions for transmissions, and more particularly to lubricant compositions which are free from a reduction in anti-shudder properties even after prolonged use. The lubricant compositions are particularly useful for automatic transmissions and continuously variable transmissions.

In recent years, with the objective of the cost reduction of oil changes and the reduction of the amount of waste oil, a demand has arisen for transmission lubricant compositions which have long duration of life and can maintain their properties even after the long-time use.

In addition to automatic transmissions, most of continuously variable transmissions are equipped with a torque converter. Recently, lock-up clutches have been built in torque converters as effective means to improve mileage such that in addition to power transmission via lubricant, the engine torque is directly transmitted to the transmission. However, a torque converter clutch works only in a high-speed range where the engine torque fluctuations are less. When the torque converter works in a low-speed range, the engine torque fluctuations bring about abnormal vibration of the car body, leading to unpleasant driving conditions. As a result, in the low-speed range, e.g., during the starting period, power transmission loss occurs, caused by a difference between the input and output revolutions, i.e., engine output and

transmission input, leading to a decrease in gas mileage.

In order to decrease such power transmission loss, a slip control mechanism is used in some automobiles in which the torque converter works at a low speed range and the engine torque fluctuation is absorbed by the relative slip of the clutch. However, in such a case, there is a possibility that abnormal vibration of the car body, so-called shudder, occurs at the torque converter clutch's surface, resulting in uncomfortable riding conditions. In order to prevent the occurrence of shudder, the lubricant is required to have improved μ (friction coefficient)- V (sliding velocity) properties such that the friction coefficient increases as sliding velocity increases. The use of friction modifiers is effective to improve the μ - V properties and thus many friction modifiers have been proposed. However, there has not been obtained a satisfactory result with regard to long-lasting anti-shudder properties.

The transmission lubricants must maintain proper viscosity to lubricate a gear shaft bearing mechanism and particularly those used in a transmission having a hydraulic controlling mechanism are required to maintain proper viscosity so as to prevent it from leaking from the control valve. Furthermore, the transmission lubricants are required to show less viscosity reduction, even after the use for extended periods of time. In addition to this, the transmission lubricants are also required to have an excellent low temperature fluidity because the increase of its resistance to stirring under cold conditions invite the decrease of gas mileage and therefore, viscosity at low temperatures are importantly needed to be low.

In view of the foregoing circumstances, there has been a great deal of need to develop a lubricant for transmissions which has in addition to long-lasting anti-shudder properties excellent low temperature fluidity and shear stability.

It is an object of the present invention to provide transmission lubricant compositions which have and maintains excellent shear stability and anti-shudder properties for extended periods of time without being degraded.

According to the present invention, there is provided a transmission lubricant composition comprising a mineral oil as a base oil hereinafter referred to as Component (A) of which $\%C_p$ and $\%C_A$ defined by ASTM D3238 are 70 or more and 3 or less, respectively, as a main component, as a main component, a viscosity-index improver hereinafter referred to as Component (B), and a friction modifier hereinafter referred to as Component (C).

The present invention is described below in more detail in relation to preferred embodiments.

A mineral oil having a $\%C_p$ of 70 or more and a $\%C_A$ of 3 or less both of which are defined by ASTM D3238, are used as Component (A) in the present invention.

Since Component (A) fulfills the conditions of $\%C_p \geq 70$ and $\%C_A \leq 3$, the composition of the present invention exhibits excellent low temperature fluidity and long lasting anti-shudder properties synergistically with Components (B) and (C).

No particular limitation is imposed on the kinematic viscosity of Component (A). However, Component (A) preferably has a kinematic viscosity at 100°C of from 1 to 10 mm²/s, particularly preferably from 1 to 4 mm²/s. The use of a mineral base oil having a kinematic viscosity at 100°C of 1.0 mm²/s or more can form oil film and provide lubricity for the lubricant composition and moreover can reduce the evaporation loss of the base oil at elevated temperatures. The use of a mineral base oil having a kinematic viscosity at 100°C of 10 mm²/s or less can reduce the flow resistance of itself, resulting in a lubricant composition

having a lower friction resistance at friction parts. The use of a mineral base oil having a kinematic viscosity at 100 ° C of 4 mm²/s or less can further enhance the low temperature fluidity of the resulting lubricant composition.

No particular limitation is imposed on the viscosity index of Component (A) as well. However, the viscosity index of Component (A) is preferably 50 or more and particularly preferably 80 or more. The use of a base oil having a viscosity index of 50 or more is contributive to the production of a lubricant composition which are further superior in the capabilities of both oil film formation and flow resistance reduction.

Mineral oils used as Component (A) may be produced any suitable method. For example, mineral oils which may be used include paraffinic and naphthenic mineral oils which are produced by subjecting lubricant fractions resulting from the atmospheric distillation and vacuum distillation of crude oil to refining processes such as solvent deasphalting, solvent extraction, hydrocracking, solvent dewaxing, catalytic dewaxing, hydrorefining, sulfuric acid washing, and clay treatment in suitable combination; and n-paraffinic mineral oils.

More specifically, mineral base oils can be obtained by refining the starting oil as it is or the lubricant fractions recovered therefrom through the usual refining processes and then recovering the lubricant fractions. The starting oil may be (i) distillate oils resulting from the atmospheric distillation of a paraffin based crude oil and/or of a mixed base crude oil; (ii) distillate oils resulting from the vacuum distillation of the topped crude of a paraffin based crude oil and/or of a mixed base crude oil; (iii) oils resulting from mild hydrocracking of oils (i) and/or (ii); (iv) mixed oils of two or more selected from oils (i), (ii), and (iii); (v) deasphalted oils of oils (i) to (iv), (vi) oils resulting from mild hydrocracking of oils (v); and (vii) mixed oils of two or more selected from

oils (i) to (vi).

There is no restriction to the usual refining processes mentioned above which may be any of the refining methods used upon production of lubricant base oils. Specific examples of such refining methods are (a) hydro-refining such as hydrocracking and hydro-finishing; (b) solvent refining such as furfural extraction; (c) dewaxing such as solvent dewaxing and catalytic dewaxing; (d) clay treatment with acid clay or active clay; and (e) acid or alkali chemical refining such as sulfuric acid washing and caustic soda washing. In the production of the lubricant composition of the present invention, the above-described methods may be used individually or in combination in any order. Needless to mention, the refining condition of each of the refining methods, i.e., the temperature and pressure in the hydro-refining is suitably selected such that a mineral oil having the desired properties can be obtained.

The mineral oils which may be used as Component (A) of the present invention can be easily obtained by utilizing preferably 50 percent by mass or more, more preferably 70 percent by mass or more, particularly preferably 80 percent by mass or, based on the total mass of the base oil, of a component produced by hydrocracking the starting oil selected from the oils (i) to (vii) as it is or the lubricant fraction recovered therefrom; solvent- or catalytic dewaxing the resulting product as it is or the lubricant fraction recovered therefrom; and solvent-refining the resulting product or such as solvent- or solvent- or catalytic dewaxing the resulting product after the solvent-refining.

Component (A) may be a mixture of two or more kinds of refined mineral oils obtained by any of the above-described refining processes or a single refined mineral oil by the same. However, in any case, the mineral oils used as Component (A) of the present invention must fulfil the conditions of $\%C_P \geq 70$ and $\%C_A \leq 3$. In other words, as long as they fulfil such

conditions, any kind of mineral oils can be used as Component (A). Therefore, the mineral oils which may be used as Component (A) may contain small amounts of synthetic oils such as poly- α -olefins and ester-based synthetic oils.

Eligible viscosity index improvers, i.e., Component (B) of the present invention are non-dispersion type and dispersion type viscosity index improvers.

Specific examples of the non-dispersion type viscosity index improvers are polymers or copolymers obtained by polymerizing one or more monomers represented by formulae (1), (2) and (3) below, and hydrides of these polymers:



and



Specific examples of the dispersion type-viscosity index improvers are copolymers of two or more monomers selected from the group consisting of compounds represented by formulae (4) and (5) below and hydrides thereof and copolymers of one or more monomers selected from the group consisting of compounds represented by formulae (1), (2) and (3) above with one or more monomers selected from the group consisting of compounds represented by formulae (4) and (5) below and hydrides thereof.



and



In formula (1), R¹ is hydrogen or methyl, and R² is an alkyl group having 1 to 18 carbon atoms.

Specific examples of the alkyl group having 1 to 18 carbon atoms for R² are alkyl groups, which may be straight-chain or branched, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl groups.

In formula (2), R³ is hydrogen or methyl, and R⁴ is a hydrocarbon group having 1 to 12 carbon atoms.

Specific examples of the hydrocarbon group having 1 to 12 carbon atoms are alkyl groups, which may be straight-chain or branched, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, and dodecyl groups; alkenyl groups, which may be straight-chain or branched and the position of which the double bond may vary, such as butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, and dodecenyl groups; cycloalkyl groups having 5 to 7 carbon atoms, such as cyclopentyl, cyclohexyl, and cycloheptyl groups; alkylcycloalkyl groups, of which the alkyl group may be bonded to any position of the cycloalkyl group, having 6 to 11 carbon atoms, such as methylcyclopentyl, dimethylcyclopentyl, methylethylcyclopentyl, diethylcyclopentyl, methylcyclohexyl, dimethylcyclohexyl, methylethylcyclohexyl, diethylcyclohexyl, methylcycloheptyl,

dimethylcycloheptyl, methylethylcycloheptyl, and diethylcycloheptyl groups; aryl groups such as phenyl and naphthyl groups; alkylaryl groups, of which the alkyl group may be straight-chain or branched and bond to any position of the aryl group, having 7 to 12 carbon groups, such as tolyl, xylyl, ethylphenyl, propylphenyl, butylphenyl, pentylphenyl, and hexylphenyl groups; and phenylalkyl groups, of which the alkyl group may be straight-chain or branched, having 7 to 12 carbon atoms, such as benzyl, phenylethyl, phenylpropyl, phenylbutyl, phenylpentyl, and phenylhexyl groups.

In formula (3), D^1 and D^2 are each independently hydrogen, a residue of an alkylalcohol having 1 to 18 carbon atoms represented by the formula $-OR^5$ wherein R^5 is an alkyl group having 1 to 18 carbon atoms, or a residue of a monoalkylamine having 1 to 18 carbon atoms represented by the formula $-NHR^6$ wherein R^6 is an alkyl group having 1 to 18 carbon atoms.

Specific examples of the alkyl group for R^5 and R^6 are the same as those exemplified with regard to R^2 in formula (1).

Among the monomers of formulae (1), (2), and (3), preferred are alkylacrylates and alkylmethacrylates of formula (1); olefins of formula (2) wherein R^3 is hydrogen or methyl, and R^4 is an alkyl group having 1 to 12 carbon atoms; styrene of formula (2) wherein R^3 is hydrogen, and R^4 is phenyl; α -methylstyrene of formula (2) wherein R^3 is methyl, and R^4 is phenyl; p-methylstyrene of formula (2) wherein R^3 is hydrogen, and R^4 is tolyl; maleates of formula (3) wherein D^1 and D^2 are $-OR^5$ wherein R^5 is alkyl; and maleic amides of formula (3) wherein D^1 and D^2 are $-NHR^6$ wherein R^6 is alkyl.

In formula (4), R^7 is hydrogen or methyl, R^8 is an alkylene group having 1 to 18 carbon atoms, E^1 is an amine residue or heterocyclic residue having 1 or 2 nitrogen and 0 to 2 oxygen, and a is an integer of 0 or 1.

Specific examples of the alkylene group having 1 to 18 carbon atoms for

R⁸ are ethylene, propylene, butylene, pentylene, hexylene, heptylene, octylene, nonylene, decylene, undecylene, dodecylene, tridecylene, tetradecylene, pentadecylene, hexadecylene, heptadecylene, and octadecylene groups, all of which may be straight-chain or branched.

Specific examples of the amine residue for E¹ are dimethylamino, diethylamino, dipropylamino, dibutylamino, anilino, toluidino, xylydino, acetylamino, and benzoilamino. Specific examples of the heterocyclic residue are morpholino, pyrrolyl, pyridyl, methylpyridyl, pyrrolidinyl, piperidinyl, quinonyl, pyrrolidonyl, pyrrolidono, imidazolino, and pyrazino groups.

In formula (5), R⁹ is hydrogen or methyl, and E² is an amine residue or heterocyclic residue having 1 or 2 nitrogen and 0 to 2 oxygen.

Specific examples of the amine residue for E² are dimethylamino, diethylamino, dipropylamino, dibutylamino, anilino, toluidino, xylydino, acetylamino, and benzoilamino. Specific examples of the heterocyclic residue are morpholino, pyrrolyl, pyridyl, methylpyridyl, pyrrolidinyl, piperidinyl, quinonyl, pyrrolidonyl, pyrrolidono, imidazolino, and pyrazino groups.

Among the monomers of formulae (4), (5), and (6), preferred are dimethylaminomethacrylate of formula (4) wherein R⁷ is methyl, R⁸ is methylene, and E¹ is dimethylamino; diethylaminomethylmethacrylate of formula (4) wherein R⁷ is methyl, R⁸ is methylene, and E¹ is diethylamino; dimethylaminoethylmethacrylate of formula (4) wherein R⁷ is methyl, R⁸ is ethylene, and E¹ is dimethylamino; diethylaminoethylmethacrylate of formula (4) wherein R⁷ is methyl, R⁸ is ethylene, and E¹ is diethylamino; morpholinomethylmethacrylate of formula (4) wherein R⁷ is methyl, R⁸ is methylene, and E¹ is morpholino; morpholinoethylmethacrylate of formula (4) wherein R⁷ is methyl, R⁸ is ethylene, and E¹ is morpholino; 2-vinyl-5-methylpyridine of formula (5) wherein R⁹ is hydrogen, and E² is 5-

methypyridyl; and N-vinylpyrrolidone of formula (5) wherein R⁹ is hydrogen and E² is pyrrolidono.

When one or more monomers represented by formula (1), (2) or (3) is copolymerized with one or more monomers represented by formula (4) or (5), the molar ratio of the former monomers to the latter monomers is arbitrary selected but is within the range of 80 : 20 to 95 : 5. The copolymerization is conducted using any suitable conventional method, such as by radical-solution polymerization of the monomers in the presence of a polymerization initiator such as benzoyl peroxide.

Specific examples of Component (B), i.e., viscosity index improvers are polymethacrylates, ethylene- α -olefin copolymers and hydrides thereof, polyisobutylene and hydrides thereof, styrene-diene hydrogenated copolymers, styrene-maleic anhydrides copolymers, and polyalkylstyrene. These viscosity index improvers may be of either dispersion type or non-dispersion type. However, preferred are dispersion type viscosity index improvers because of their capability to maintain anti-shudder properties.

Preferred for Component (B) are polymethacrylates because they are superior in an enhancement in low temperature fluidity. The molecular weight of polymethacrylates is preferably selected in view of shear stability. In general, preferred polymethacrylates are those having a weight-average molecular weight of 10,000 to 200,000, preferably 10,000 to 60,000 in view of the prolonged use.

No particular limitation is imposed on the content of Component (B). In general, it is contained in an amount of preferably 0.1 to 25 percent by mass, more preferably 0.5 to 20 percent by mass, based on the total mass of the transmission lubricant composition. A content of Component (B) which is less than 0.1 percent by mass would be poor in effect to improve low temperature

fluidity, while that in excess of 25 percent by mass would fail to exhibit an effect corresponding to the amounts.

Component (C) of the present invention is a friction modifier. Eligible friction modifiers are preferably those having in its molecules at least one alkyl or alkenyl group having 6 to 30, more preferably 9 to 24 carbon atoms and no hydrocarbon

group having 31 or more carbon atoms. The alkyl or alkenyl group may be straight-chain or branched. However, those having less than 6 or more than 30 carbon atoms are not preferred because they possibly deteriorate the friction properties in a wet clutch.

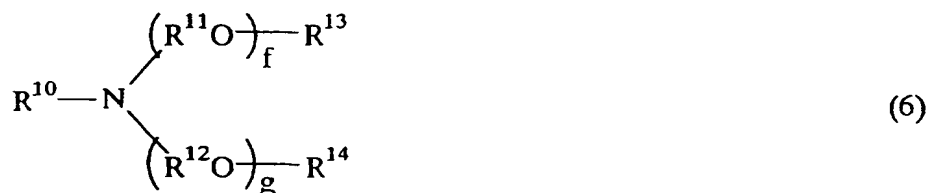
Specific examples of the alkyl and alkenyl groups are alkyl groups, which may be straight-chain or branched, such as hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl (lauryl), tridecyl, tetradecyl (myristyl), pentadecyl, hexadecyl (palmityl), heptadecyl, octadecyl (stearyl), nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl and triacontyl groups; and alkenyl groups, which may be straight-chain or branched and the position of which the double bond may vary, such as hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, tridecenyl, tetradecenyl, pentadecenyl, hexadecenyl, heptadecenyl, octadecenyl (oleyl), nonadecenyl, eicosenyl, heneicosenyl, docosenyl, tricosenyl, tetracosenyl, pentacosenyl, hexacosenyl, heptacosenyl, octacosenyl, nonacosenyl and triacontenyl groups.

Preferred friction modifiers for the present invention are as follows:
(C-1) an amine compound having in its molecules at least one alkyl or alkenyl group having 6 to 30 carbon atoms and no hydrocarbon group having 31 or more carbon atoms, and derivatives thereof;
(C-2) a phosphorus compound having in its molecules at least one alkyl or alkenyl group having 6 to 30 carbon atoms and no hydrocarbon group having

31 or more carbon atoms, and derivatives thereof, and

(C-3) an amide or metallic salt of a fatty acid having in its molecules at least one alkyl or alkenyl group having 6 to 30 carbon atoms and no hydrocarbon group having 31 or more carbon atoms.

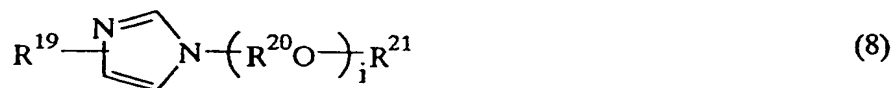
Specific examples of (C-1) the amine compound are aliphatic monoamines represented by the formula or alkyleneoxide adducts thereof



aliphatic polyamines represented by the formula



and imidazoline compounds represented by the formula



In formula (6), R^{10} is an alkyl or alkenyl group having 6 to 30, preferably 9 to 24 carbon atoms, R^{11} and R^{12} are each independently ethylene or propylene, R^{13} and R^{14} are each independently hydrogen or a hydrocarbon group having 1 to 30 carbon atoms, f and g are each independently an integer of 0 to 10, preferably 0 to 6, and $f + g = 0$ to 10, preferably 0 to 6.

In formula (7), R^{15} is an alkyl or alkenyl group having 6 to 30, preferably 9 to 24 carbon atoms, R^{16} is ethylene or propylene, R^{17} and R^{18} are each independently hydrogen or a hydrocarbon group having 1 to 30 carbon atoms, h is an integer of 1 to 5, preferably 1 to 4.

In formula (8), R^{19} is an alkyl or alkenyl group having 6 to 30,

preferably 9 to 24 carbon atoms, R^{20} is ethylene or propylene, R^{21} is hydrogen or a hydrocarbon group having 1 to 30 carbon atoms, and i is an integer of 0 to 10, preferably 0 to 6.

The alkyl or alkenyl group for R^{10} , R^{15} , and R^{19} may be straight-chain or branched but have 6 to 30 carbon atoms, preferably 9 to 24 carbon atoms.

Specific examples of the alkyl or alkenyl groups for R^{10} , R^{15} , and R^{19} are alkyl groups, which may be straight-chain or branched, such as hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl (lauryl), tridecyl, tetradecyl (myristyl), pentadecyl, hexadecyl (palmityl), heptadecyl, octadecyl (stearyl), nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl and triacontyl groups; and alkenyl groups, which may be straight-chain or branched and the position of which the double bond may vary, such as hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, tridecenyl, tetradecenyl, pentadecenyl, hexadecenyl, heptadecenyl, octadecenyl (oleyl), nonadecenyl, eicosenyl, heneicosenyl, docosenyl, tricosenyl, tetracosenyl, pentacosenyl, hexacosenyl, heptacosenyl, octacosenyl, nonacosenyl and triacontenyl groups. Among these, particularly preferred are alkyl or alkenyl groups having 12 to 18 carbon atoms, such as lauryl, myristyl, palmityl, stearyl, isostearyl (16-methylheptadecyl), and oleyl groups because they can provide superior friction properties in a wet clutch.

Specific examples of the group for each R^{13} , R^{14} , R^{17} , R^{18} , and R^{21} are hydrogen; alkyl groups, which may be straight-chain or branched, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl and triacontyl groups; alkenyl groups, which may be straight-chain or branched and wherein the position of

the double bond may vary, such as butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, tridecenyl, tetradecenyl, pentadecenyl, hexadecenyl, heptadecenyl, octadecenyl, nonadecenyl, eicosenyl, heneicosenyl, docosenyl, tricosenyl, tetracosenyl, pentacosenyl, hexacosenyl, heptacosenyl, octacosenyl, nonacosenyl and triacontenyl groups; cycloalkyl groups having 5 to 7 carbon atoms, such as cyclopentyl, cyclohexyl and cycloheptyl groups; alkylcycloalkyl groups, of which the alkyl group may bond to any position of the cycloalkyl group, having 6 to 11 carbon atoms, such as methylcyclopentyl, dimethylcyclopentyl, methylethylcyclopentyl, diethylcyclopentyl, methylcyclohexyl, dimethylcyclohexyl, methylethylcyclohexyl, diethylcyclohexyl, methylcycloheptyl, dimethylcycloheptyl, methylethylcycloheptyl and diethylcycloheptyl groups; aryl groups such as phenyl and naphthyl groups; alkylaryl groups, of which the alkyl group may be straight-chain or branched and may bond to any position of the aryl group, having 7 to 18 carbon atoms, such as tolyl, xylyl, ethylphenyl, propylphenyl, butylphenyl, pentylphenyl, hexylphenyl, heptylphenyl, octylphenyl, nonylphenyl, decylphenyl, undecylphenyl and dodecylphenyl groups; and arylalkyl groups, of which the alkyl group may be straight-chain or branched, having 7 to 12 carbon atoms, such as benzyl, phenylethyl, phenylpropyl, phenylbutyl, phenylpentyl and phenylhexyl groups.

Among the aliphatic monoamines of formula (6) and alkyleneoxide adducts thereof, more preferred are those of formula (6) wherein R^{13} and R^{14} are each independently hydrogen or an alkyl group having 1 to 6 carbon atoms, and $f = g = 0$, and alkyleneoxide adducts of aliphatic monoamines of formula (6) wherein both R^{13} and R^{14} are hydrogen, and f and g are each independently an integer of 0 to 6 and $f + g = 1$ to 6 because of their good friction properties in a wet clutch.

Among the aliphatic polyamines of formula (7), preferred are those of formula (7) wherein R^{17} and R^{18} are each independently hydrogen or an alkyl group having 1 to 6 carbon atoms because of their good friction properties in a wet clutch.

Among the imidazoline compounds of formula (8), preferred are those of formula (8) wherein R^{21} is hydrogen or an alkyl group having 1 to 6 carbon atoms because of their good friction properties in a wet clutch.

First examples of derivatives of the amine compounds also referred to as (C-1) are acid-modified compounds obtained by allowing the above-described amine compound of formula (6), (7) or (8) to react with monocarboxylic acid (aliphatic acid) having 2 to 30 carbon atoms or polycarboxylic acid having 2 to 30 carbon atoms, such as oxalic acid, phthalic acid, trimellitic acid, and pyromellitic acid so as to neutralize the whole or part of the remaining amino and/or imino groups or to convert the whole or part of the same into amide. Second examples are boron-modified compounds obtained by allowing the above-described amine compound of formula (6), (7) or (8) to react with boric acid so as to neutralize the whole or part of the remaining amino and/or imino groups. Third examples are salts of phosphates obtained by allowing the above-described amine compound of formula (6), (7) or (8) to react with acid phosphate or acid phosphite each having in its molecules one or two hydrocarbon groups having 1 to 30 carbon atoms but no hydrocarbon group having 31 or more carbon atoms and having at least one hydroxyl group so as to neutralize the whole or part of the remaining amino or imino groups. Fourth examples are alkyleneoxide adducts of amine compounds obtained by allowing the amine compound of formula (7) or (8) to react with an alkylene oxide such as ethylene oxide and propylene oxide. Other than these compounds, there may be used modified products obtained by subjecting the amine compound of

formula (6), (7), or (8) to two or more of the aforesaid modifications.

Therefore, in view of the capability to provide excellent friction properties in a wet clutch, preferred amine compound and derivatives thereof referred to as Component (C-1) are as follows:

- (i) amine compounds such as lauryl amine, lauryl diethylamine, lauryl diethanolamine, dodecyldipropylamine, palmitylamine, stearylamine, stearyltetraethylenepentamine, oleylamine, oleylpropylenediamine, oleyldiethanolamine, and N-hydroxyethyloleylimidazolyne;
- (ii) alkyleneoxide adducts of the above amine compounds (i);
- (iii) salts of the above amine compounds (i) and acid phosphate such as di-2-ethylhexylphosphate or acid phosphite such as 2-ethylhexylphosphite;
- (iv) boric acid-modified product of the above amine compounds (i), the above alkyleneoxide adducts (ii) or the salts (iii); and
- (v) mixtures of any two or more of (i), (ii), (iii), and (iv).

Phosphorus compounds referred to as Component (C-2) are phosphates represented by the formula



and

phosphites represented by the formula



In formula (9), R²² is an alkyl or alkenyl group having 6 to 30, 9 to 24 carbon atoms, R²³ and R²⁴ are each independently hydrogen or a hydrocarbon group having 1 to 30 carbon atoms, F¹, F², F³, and F⁴ are each independently

oxygen or sulfur, provided that at least one of F^1 , F^2 , F^3 , and F^4 is oxygen.

In formula (10), R^{25} is an alkyl or alkenyl group having 6 to 30, preferably 9 to 24 carbon atoms, R^{26} and R^{27} are each independently hydrogen or a hydrocarbon group having 1 to 30 carbon atoms, F^5 , F^6 , and F^7 are each independently oxygen or sulfur provided that at least one of F^5 , F^6 , and F^7 is oxygen.

The alkyl and alkenyl group for R^{22} and R^{25} may be straight-chain or branched ones but have 6 to 30, preferably 9 to 24 carbon atoms. Departures from the above-specified range of carbon number would cause a deterioration in friction properties in a wet clutch.

Specific examples of the alkyl or alkenyl groups for R^{22} and R^{25} are alkyl groups, which may be straight-chain or branched, such as hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl (lauryl), tridecyl, tetradecyl (myristyl), pentadecyl, hexadecyl (palmityl), heptadecyl, octadecyl (stearyl), nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl and triacontyl groups; and alkenyl groups, which may be straight-chain or branched and the position of which the double bond may vary, such as hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, tridecenyl, tetradecenyl, pentadecenyl, hexadecenyl, heptadecenyl, octadecenyl (oleyl), nonadecenyl, eicosenyl, heneicosenyl, docosenyl, tricosenyl, tetracosenyl, pentacosenyl, hexacosenyl, heptacosenyl, octacosenyl, nonacosenyl and triacontenyl groups. Among these, particularly preferred are straight-chain alkyl or alkenyl groups having 12 to 18 carbon atoms, such as lauryl, myristyl, palmityl, stearyl, and oleyl groups with because they can provide superior friction properties in a wet clutch.

Specific examples of the hydrocarbon group for R^{23} , R^{24} , R^{26} , and R^{27} are alkyl groups, which may be straight-chain or branched, such as methyl, ethyl,

propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl and triacontyl groups; alkenyl groups, which may be straight-chain or branched and wherein the position of the double bond may vary, such as butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, tridecenyl, tetradecenyl, pentadecenyl, hexadecenyl, heptadecenyl, octadecenyl, nonadecenyl, eicosenyl, heneicosenyl, docosenyl, tricosenyl, tetracosenyl, pentacosenyl, hexacosenyl, heptacosenyl, octacosenyl, nonacosenyl and triacontenyl groups; cycloalkyl groups having 5 to 7 carbon atoms, such as cyclopentyl, cyclohexyl and cycloheptyl groups; alkylcycloalkyl groups, of which the alkyl group may bond to any position of the cycloalkyl group, having 6 to 11 carbon atoms, such as methylcyclopentyl, dimethylcyclopentyl, methylethylcyclopentyl, diethylcyclopentyl, methylcyclohexyl, dimethylcyclohexyl, methylethylcyclohexyl, diethylcyclohexyl, methylcycloheptyl, dimethylcycloheptyl, methylethylcycloheptyl and diethylcycloheptyl groups; aryl groups such as phenyl and naphthyl groups; alkylaryl groups, of which the alkyl group may be straight-chain or branched and may bond to any position of the aryl group, having 7 to 18 carbon atoms, such as tolyl, xylyl, ethylphenyl, propylphenyl, butylphenyl, pentylphenyl, hexylphenyl, heptylphenyl, octylphenyl, nonylphenyl, decylphenyl, undecylphenyl and dodecylphenyl groups; and arylalkyl groups, of which the alkyl group may be straight-chain or branched, having 7 to 12 carbon atoms, such as benzyl, phenylethyl, phenylpropyl, phenylbutyl, phenylpentyl and phenylhexyl groups.

Because their excellent friction properties in a wet clutch, preferred phosphorus compounds as Component (C-2) are acid phosphates represented

by formula (9) wherein at least one of R^{23} and R^{24} is hydrogen and acid phosphites represented formula (10) wherein at least one of R^{26} and R^{27} is hydrogen.

Specific examples of the derivatives of the phosphoric compounds also referred to as Component (C-2) are salts obtained by allowing an acid phosphite of formula (9) wherein at least one of R^{23} and R^{24} is hydrogen or an acid phosphite of formula (10) wherein at least one of R^{26} and R^{27} is hydrogen to react with a nitrogen-containing compound such as ammonia or an amine compound having in its molecules only hydrocarbon or hydroxyl-containing groups having 1 to 8 carbon atoms so as to neutralize the whole or part of the remaining acid hydrogen.

Specific examples of such a nitrogen-containing compound are ammonia; alkylamines, of which the alkyl group may be straight-chain or branched, such as monomethylamine, monoethylamine, monopropylamine, monobutylamine, monopentylamine, monohexylamine, monoheptylamine, monooctylamine, dimethylamine, methylethylamine, diethylamine, methylpropylamine, ethylpropylamine, dipropylamine, methylbutylamine, ethylbutylamine, propylbutylamine, dibutylamine, dipentylamine, dihexylamine, diheptylamine and dioctylamine; alkanolamines, of which the alkanol group may be straight-chain or branched, such as monomethanolamine, monoethanolamine, monopropanolamine, monobutanolamine, monopentanolamine, monohexanolamine, monoheptanolamine, monooctanolamine, monononanolamine, dimethanolamine, methanolethanolamine, diethanolamine, methanolpropanolamine, ethanolpropanolamine, dipropanolamine, methanolbutanolamine, ethanolbutanolamine, propanolbutanolamine, dibutanolamine, dipentanolamine, dihexanolamine, diheptanolamine and dioctanolamine; and

mixtures thereof.

Because of their excellent friction properties in a wet clutch, particularly preferred phosphorus compounds as Component (C-2) are monolauryl phosphate, dilauryl phosphate, monostearyl phosphate, distearyl phosphate, monooleyl phosphate, dioleyl phosphate, monolauryl phosphite, dilauryl phosphite, monostearyl phosphite, distearyl phosphite, monooleyl phosphite, dioleylphosphite, monolauryl thiophosphate, dilauryl thiophosphate, monostearyl thiophosphate, distearyl thiophosphate, monooleyl thiophosphate, dioleyl thiophosphate, monolauryl thiophosphate, dilauryl thiophosphite, monostearyl thiophosphite, distearyl thiophosphite, monooleyl thiophosphite, dioleyl thiophosphite; amine salts of these phosphates such as mono-2-ethylhexylamine salts, phosphite, thiophosphate and thiophosphite; and mixtures thereof.

The fatty acid amide or fatty metal salt referred to as Component (C-3) may be straight-chain or branched and saturated or unsaturated fatty acids but the alkyl group or alkenyl group thereof has 6 to 30, preferably 9 to 24 carbon atoms. Fatty acids having an alkyl or alkenyl group having fewer than 6 or 31 or greater carbon atoms are not preferred because they would cause the deterioration of friction properties in a wet clutch.

Specific examples of the fatty acid are straight-chain or branched saturated fatty acids, such as heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, octadecanoic acid, nonadecanoic acid, icosanoic acid, heneicosanoic acid, docosanoic acid, tricosanoic acid, tetracosanoic acid, pentacosanoic acid, hexacosanoic acid, heptacosanoic acid, octacosanoic acid, nonacosanoic acid, and triacontanoic acid; and straight-chain or branched unsaturated fatty acids, wherein the

position the double bond may vary, such as heptanoic acid, octenoic acid, nonenoic acid, decenoic acid, undecenoic acid, dodecenoic acid, tridecenoic acid, tetradecenoic acid, pentadecenoic acid, hexadecenoic acid, heptadecenoic acid, octadecenoic acid, nonadecenoic acid, eicosenoic acid, heneicosenoic acid, docosenoic acid, tricosenoic acid, tetracosenoic acid, pentasenoic acid, hexacosenoic acid, heptacosenoic acid, octacosenoic acid, nonacosenoic acid and triacontenoic acid. Because of their excellent friction properties in a wet clutch, particularly preferred fatty acids are straight-chain fatty acids derived from various types of fats and oils such as lauric acid, myristic acid, palmitic acid, stearic acid and oleic acid and mixtures of straight-chain fatty acid and branched fatty acid obtained by the oxo synthesis.

The fatty acid amide referred to as Component (C-3) may be amides obtained by reacting a nitrogen-containing compound such as ammonia and amine compound having per molecule only hydrocarbon or hydroxyl-containing hydrocarbon groups having 1 to 8 carbon atoms.

Specific examples of such a nitrogen-containing compound are ammonia; alkylamine, of which the alkyl group may be straight-chain or branched, such as monomethylamine, monoethylamine, monopropylamine, monobutylamine, monopentylamine, monohexylamine, monoheptylamine, monooctylamine, dimethylamine, methylethylamine, diethylamine, methylpropylamine, ethylpropylamine, dipropylamine, methylbutylamine, ethylbutylamine, propylbutylamine, dibutylamine, dipentylamine, dihexylamine, diheptylamine and dioctylamine; and alkanolamines, of which the alkanol group may be straight-chain or branched, such as monomethanolamine, monoethanolamine, monopropanolamine, monobutanolamine, monopentanolamine, monohexanolamine, monoheptanolamine, monooctanolamine, monononanolamine,

dimethanolamine, methanolethanolamine, diethanolamine, methanolpropanolamine, ethanolpropanolamine, dipropanolamine, methanolbutanolamine, ethanolbutanolamine, propanolbutanolamine, dibutanolamine, dipentanolamine, dihexanolamine, diheptanolamine, and dioctanolamine.

Because of their excellent friction properties in a wet clutch, specific examples of the fatty acid amides as Component (C-3) are lauric acid amide, lauric acid diethanolamide, lauric monopropylamine, myristic acid amide, myristic acid diethanolamide, myristic acid monopropylamine, palmitic acid amide, palmitic acid ethanolamide, palmitic acid monopropylamine, stearic acid amide, stearic acid diethanolamide, stearic acid monopropylamine, oleic acid amide, oleic acid diethanolamide, oleic acid monopropylamine, coconut oil fatty amide, coconut oil fatty acid diethanolamide, coconut oil fatty monopropylamine, synthetic mixed fatty amides having 12 to 13 carbon atoms, synthetic mixed fatty diethanolamides having 12 to 13 carbon atoms, synthetic mixed fatty monopropylamines having 12 to 13 carbon atoms, and mixtures thereof.

Specific examples of the fatty metallic acid also referred to as Component (C-3) are alkaline earth metal salts such as a magnesium salt and a calcium salt, and a zinc salt of any of the above-exemplified fatty acids. Because of their excellent friction properties in a wet clutch, particularly preferred fatty acid metallic salts are calcium laurate, calcium myristate, calcium palmitate, calcium stearate, calcium oleate, coconut oil fatty acid calcium, synthetic mixed fatty acid calcium having 12 or 13 carbon atoms, zinc laurate, zinc myristate, zinc palmitate, zinc stearate, zinc oleate, coconut oil fatty zinc, synthetic mixed fatty zinc having 12 to 13 carbon atoms, and mixtures thereof.

Any one or more members arbitrary selected from the above-described Components (C-1) through (C-3) may be added to the transmission lubricant composition of the present invention in any suitable amount as long as they do not adversely affect the other properties of the resulting composition such as oxidation stability. In order to obtain long-lasting friction properties of the composition, it is necessary to avoid a deterioration in friction properties caused by the deterioration of the friction modifier. Addition of large amounts of Component (C) is effective in obtaining long-lasting friction properties. However, too large amounts of Component (C) would lead to reduced static friction coefficient which is required to be high so as to maintain the coupling or engagement of a wet clutch. The amount of Component (C) is thus limited to some extent.

Therefore, the content of Component (C) is preferably within the range of preferably 0.005 to 3.0 mass percent, more preferably 0.01 to 2.0 mass percent, based on the total mass of the transmission lubricant composition.

The transmission lubricant composition of the present invention is obtained by blending a particular mineral base oil with suitable amounts of the viscosity index improver and friction modifier. Although the composition as such is superior in the durability of anti-shudder properties and in low temperature fluidity, in order to further enhance such properties there may be blended various additives such as anti-wear agents, extreme pressure agents, ashless dispersants, metallic detergents, oxidation inhibitors, corrosion inhibitors, anti-foaming agents and dyes. These additives may be used individually or in combination.

Anti-wear agents may be any of conventional ones for lubricants. Eligible abrasion inhibitors are one or more phosphorus compounds such as

salts of monophosphates, diphosphates, triphosphates, monophosphites, diphosphites, triphosphites, or these esters with amines or alkanolamines. The content of such abrasion inhibitors is selected from the range of 0.005 to 2 percent by mass, based on the total mass of the transmission lubricant composition.

Extreme pressure agents may be any of conventional ones for lubricants. Eligible extreme pressure agents are sulfuric compounds such as disulfides, olefin sulfides, and sulfurized fats and oils. One or more of these compounds is preferably added in an amount of 0.1 to 5.0 percent by mass based on the total mass of the transmission lubricant composition.

Ashless dispersants may be any of conventional ones for lubricants, such as amino- or imino-compounds having their molecules at least one alkyl or alkenyl group having 40 to 400 carbon atoms, and modified products thereof.

The alkyl and alkenyl groups may be straight-chain or branched. Preferred are branched alkyl and alkenyl groups derived from oligomers of olefins such as propylene, 1-butene, and isobutylene or cooligomers of ethylene and propylene. The alkyl and alkenyl groups have preferably 60 to 350 carbon atoms. Alkyl and alkenyl groups having fewer than 40 carbon atoms would result in a compound having poor solubility to the lubricating base oil, those having over 400 carbon atoms would deteriorate the low temperature fluidity of the transmission lubricant composition.

Examples of derivatives of the amino and/or imino compounds are (i) acid-modified compounds obtained by allowing the above-described amino or imino compound to react with monocarboxylic acid having 2 to 30 carbon atoms, such as fatty acid or polycarboxylic acid having 2 to 30 carbon atoms, such as oxalic acid, phthalic acid, trimellitic acid, and pyromellitic acid to neutralize the whole or part of the remaining amino and/or imino groups or to convert the

whole or part of the same into amide; (ii) boron-modified compounds obtained by allowing the above-described amino or imino compound to react with boric acid to neutralize the whole or part of the remaining amino and/or imino groups or to convert the whole or part of the same into amide; and (iii) sulfur-modified compounds obtained by allowing the above-described amino or imino compound to react with a sulfuric compound.

There may be blended the above-described amino and imino compounds and one or more modified products thereof as the ashless dispersant. The content thereof is selected from the range of 0.1 to 10 percent by mass, based on the total mass of the transmission lubricant composition.

Metallic detergents may be any of conventional ones for lubricants. Eligible metallic detergents are sulfonates, phenates, and salicylates of alkaline metals or alkaline earth metals. These compounds may be used individually or in combination. Examples of the alkaline metals are sodium and potassium, while examples of the alkaline earth metals are calcium and magnesium. Specific examples of the metallic detergent are sulfonates, phenates and salicylates of calcium or magnesium.

The content of the metallic detergent is arbitrary selected, depending on the properties required for the transmission lubricant composition. In general, the metallic detergent is blended in an amount of 0.1 to 5.0 percent by mass, based on the total mass of the transmission lubricant composition.

Oxidation inhibitors are any of conventional ones for lubricants. Eligible oxidation inhibitors are phenol- or amine-based compounds. These may be used individually or in combination. Specific examples of the oxidation inhibitor are alkylphenols such as 2,6-di-tert-butyl-4-methylphenol, bisphenols such as methylene-4,4-bisphenol(2,6-di-tert-butyl-4-methylphenol), naphthylamines such as phenyl- α -naphthylamine, dialkyldiphenylamines, zinc

dialkyldithiophosphates such as zinc di-2-ethylhexyldithiophosphate, esters of 3,5-di-tert-butyl-4-hydroxyphenyl fatty acid (propionic acid) with a mono- or poly-hydric alcohol such as methanol, octadecanol, 1,6 hexanediol, neopentyl glycol, thiodiethylene glycol, triethylene glycol or pentaerythritol.

The oxidation inhibitor is blended in an amount of 0.01 to 5.0 percent by mass based on the total mass of the transmission lubricant composition.

Corrosion inhibitors may be conventional ones for lubricants. Eligible corrosion inhibitors are benzotriazole-, tolyltriazole-, thiodiazole- and imidazole-based compounds. These may be used individually or in combination. The corrosion inhibitor is usually blended in an amount of 0.01 to 3.0 percent by mass, based on the total mass of the transmission lubricant composition.

Anti-foaming agents may be conventional ones for lubricants. Eligible anti-foaming agents are silicones such as dimethylsilicon and fluorosilicon. These may be used individually or in combination. The anti-foaming agents is usually blended in an amount of 0.001 to 0.05 percent by mass, based on the total mass of the transmission lubricant composition.

When a dye is blended in the lubricant composition of the present invention, they may be conventional ones. The dye is usually blended in an amount of 0.001 to 1.0 percent by mass, based on the total mass of the transmission lubricant composition.

The invention will be further described by way of the following examples and comparative examples which are provided for illustrative purposes only.

Transmission lubricant compositions of the present invention and of comparative examples were prepared such that the kinematic viscosity at

100 ° C of each composition is made to 7.3 mm²/s, in accordance with the formulations indicated in Table 1.

Each of the compositions was subjected to an anti-shudder durability test, a low temperature viscosity measurement, and a shear stability test. Table 1 shows the results of the durability of anti-shudder properties, low temperature fluidity, and shear stability.

Table 1

			Examples				Comparative
			1	2	3	4	Example 1
Base Oil	Mineral Oil A ¹⁾	mass%	79	55.3	12.3	79	–
	Mineral Oil B ²⁾	mass%	–	11.9	75.7	–	–
	Mineral Oil C ³⁾	mass%	–	11.8	–	–	44.9
	Mineral Oil D ⁴⁾	mass%	–	–	–	–	35.3
Kinematic Viscosity of Base Oil (100°C)		mm ² /s	2.8	2.8	3.8	2.8	2.8
%C _P of Base Oil			76	75	81	76	62
%C _A of Base Oil			2	2	0.6	2	5.6
Viscosity Index Improver A ⁵⁾		mass%	–	–	–	15	–
Viscosity Index Improver B ⁶⁾		mass%	15	15	–	–	13.8
Viscosity Index Improver C ⁷⁾		mass%	–	–	6.4	–	–
Ashless Dispersant A ⁸⁾		mass%	3	3	3	3	3
Ashless Dispersant B ⁹⁾		mass%	1	1	0.5	1	1
Anti-wear agent ¹⁰⁾		mass%	0.2	0.2	0.2	0.2	0.2
Ca-based Detergent ¹¹⁾		mass%	0.4	0.4	0.5	0.4	0.4
Oxidation Inhibitor A ¹²⁾		mass%	0.5	0.5	0.5	0.5	0.5
Oxidation Inhibitor B ¹³⁾		mass%	0.5	0.5	0.5	0.5	0.5
Friction Modifier A ¹⁴⁾		mass%	0.1	0.1	0.1	0.1	0.1
Friction Modifier B ¹⁵⁾		mass%	0.2	0.2	0.2	0.2	0.2
Corrosion Inhibitor ¹⁶⁾		mass%	0.1	0.1	0.1	0.1	0.1
Low temperature Viscosity (–40°C)		mPa·s	8300	8300	16200	8100	20400
The time taken until dμ/dV reached less than 0		h	144	144	168	120	48
Viscosity reduction after shear		%	4.8	4.8	14.2	4.8	4.3

- 1) hydro-refined mineral oil (viscosity index :110, %C_P : 76, %CA : 2.0)
- 2) hydro-refined mineral oil (viscosity index :125, %C_P : 81, %CA : 0.5)
- 3) solvent-refined mineral oil (viscosity index :95, %C_P :

- 60, %CA : 5.2)
- 4) solvent-refined mineral oil (viscosity index :100, %C_p : 67, %CA : 6.5)
 - 5) non-dispersion type polymethacrylate (weight-average molecular-weight : 40,000)
 - 6) dispersion type polymethacrylate (weight-average molecular-weight : 40,000)
 - 7) dispersion type polymethacrylate (weight-average molecular-weight : 120,000)
 - 8) polybutenylsuccinimide (bis-type)
 - 9) boric acid-modified polybutenylsuccinimide (mono-type)
 - 10) arylphosphite
 - 11) petroleum-based Ca sulfonate (total base number : 300 mgKOH/g)
 - 12) dialkyldiphenylamine-based 13) bisphenol-based
 - 14) oleylamine 15) ethoxylated oleylamine
 - 16) tolyltriazole

[Anti-shudder durability test]

The results of μ -V characteristics evaluation test using a wet clutch was used as a measure of the anti-shudder properties of a transmission lubricant composition. The μ -V characteristics was evaluated in accordance with "Test method for anti-shudder performance of automatic transmission fluids" prescribed in JASO M349-98. A transmission lubricant composition is considered to have no anti-shudder properties in the case where $d\mu/dV(50)$ or $d\mu/dV(100)$ defined by the formulae below is less than 0.

$$d\mu/dV(50) = (\mu_{50} - \mu_1)/(V_{50} - V_1)$$

$$d\mu/dV(150) = (\mu_{150} - \mu_{50}) / (V_{150} - V_{50})$$

wherein μ_1 is friction coefficient at 1 rpm,

μ_{50} is friction coefficient at 50 rpm,

μ_{150} is friction coefficient at 150 rpm,

V_1 is a sliding velocity of 0.006 m/s at 1 rpm,

V_{50} is a sliding velocity of 0.3 m/s at 50 rpm,

V_{150} is a sliding velocity of 0.9 m/s at 150 rpm.

Each of the above lubricant compositions was subjected to "Test method for Oxidation Stability of Lubricating Oils for Internal Combustion Engines" of "Testing Methods for Oxidation Stability of Lubricating Oils" prescribed in JIS K2514-1993, at a test temperature of 150 ° C, for varied test periods of time, thereby preparing various deteriorated oils. The μ -V characteristics of each deteriorated oil was evaluated. Anti-shudder durability was determined by the time taken until $d\mu/dV(50)$ or $d\mu/dV(150)$ reached less than 0.

[Low temperature viscosity evaluation]

The low temperature viscosity at -40° C of each transmission lubricant composition was measured in a low temperature liquid bath in accordance with "Gear oil low temperature viscosity determination method" prescribed in JPI-5S-26-85.

[Shear stability test]

Each of the above transmission lubricant composition was irradiated with ultrasonic wave for one hour in accordance with "Test method for shear stability of automatic transmission fluids" prescribed in JASO M347-95. The viscosity reduction rate of each composition was derived from the kinematic viscosity of before and after irradiation using the following equation:

$$\Delta V = (V_0 - V_r) / V_0 \times 100$$

wherein ΔV is viscosity reduction rate (%)

V_0 is kinematic viscosity (mm^2/s) before
irradiation

V_r is kinematic viscosity (mm^2/s) after
irradiation

As apparent from the results shown in Table 1, the transmission lubricant compositions of Examples 1 to 4 take longer time until $d\mu/dV$ values reached 0 and have excellent properties, i.e., low viscosity at low temperatures.

Whereas, the transmission lubricant composition of Comparative Example 1 contains a base oil of which %Cp and/or %CA deviates the ranges defined by the present invention and thus take shorter time until $d\mu/dV$ values reached 0 with less durable in anti-shudder properties and high viscosity at low temperatures.

CLAIMS

1. A transmission lubricant composition which comprises a mineral oil as a base oil of which %CP and %CA defined in ASTM D 3238 are 70 or more and 3 or less, respectively, a viscosity index improver, and a friction modifier.
2. The transmission lubricant composition according to claim 1 wherein said viscosity index improver is selected from the group consisting of various polymethacrylates.
3. The transmission lubricant composition according to claim 2 wherein said polymethacrylates have a weight-average molecular weight of 10,000 to 200,000.
4. The transmission lubricant composition according to claim 1 wherein said mineral oil has a kinematic viscosity at 100 ° C of 1 to 10 mm²/s.
5. The transmission lubricant composition according to claim 1 wherein said viscosity index improver is selected from the group consisting of dispersion type viscosity index improvers.
6. A transmission lubricant composition substantially as herein described.



INVESTOR IN PEOPLE

Application No: GB 0107084.6
Claims searched: 1-6

Examiner: Dr William Thomson
Date of search: 13 June 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.S): C5F (FKL), (FLA)
Int Cl (Ed.7): C10M 101/00, 101/02, 101/04, 105/04, 105/06
Other: ONLINE: CAS-ONLINE, EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2267098A (ETHYL PETROLEUM ADDITIVES INC) See whole document, in particular page 5, lines 1-10, page 41, lines 18-25, page 51, lines 5-6, Tables I-VI and claim 9	1 at least
X	EP 0713908A1 (ETHYL CORPORATION) See whole document, in particular page 3, line 53 to page 4, line 14, page 5, lines 30-48, page 7, line 40 to page 8, line 4 and claim 1	1 at least
X	US 5744430 (INOUE ET AL) See whole document, in particular column 2, line 24 to column 3, line 6, column 6, line 30 to column 7, line 26 and claim 1	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.